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BARRIERS AND SOLUTIONS FOR CONNECTING PV TO THE GRID

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ABSTRACT

This paper describes the conceptualization and initial analysis of the Issues Resolution Project, funded by the U.S. Department of Energy. The goal of this project is to identify and help remove the barriers encountered by residences and businesses seeking approval to connect photovoltaic (PV) systems to the electric utility grid. Policy initiatives such as California's $54 million buydown program and President Clinton's Million Solar Roofs program are attempting to greatly increase the number of grid-connected PV systems in the U.S. The success of these initiatives depends on the ability of consumers to easily purchase, install, and interconnect PV systems.

1. INTRODUCTION

Early experience indicates that it is quite unusual for the owners of PV systems to get their systems operational without facing significant obstacles, including unanticipated delays and expenses. In some instances, customers interested in making rooftop PV investments have abandoned their plans after facing the gauntlet put in place by utilities, building inspectors, property insurers, and others with some stake in the installation, interconnection and operation of PV systems.

Examples of the kinds of institutional barriers described by customers include: (1) unanticipated and overly burdensome technical requirements for interconnection with the local utility; (2) unanticipated and overly burdensome contract terms and conditions governing the purchase and sale of electricity; and (3) unanticipated fees, charges, and other expenses related to the installation or operation of the PV system. The rest of this paper discusses each of these issues in greater detail.

2. INTERCONNECTION REQUIREMENTS

Utility interconnection issues are emerging as a major barrier to the commercialization of customer-sited grid-connected PV systems. The issues include overly burdensome technical requirements for interconnection and the lack of uniform interconnection requirements in different states, or even within a single state.

Utilities are responsible for maintaining the safety and reliability of the electricity grid. Utilities take this responsibility seriously, and are legitimately concerned about the interconnection of equipment that may pose a threat to safety or power quality.

At the same time, utilities face a conflict of interest in having sole discretion over the criteria by which customers seeking to self-generate are allowed to interconnect. Because utilities' revenues are derived from electricity sales, utilities have a financial interest in discouraging customers from reducing the amount of electricity they buy. Even in post-restructuring regulatory regimes, it appears that most distribution utilities will be compensated based on the amount of electricity being carried on their transmission and distribution networks.

This problem is exacerbated in the case of small-scale generating facilities. Although there may be legitimate differences of opinion regarding the safety and power quality risks associated with a 2 kW PV system or a 3 kW wind turbine, it is difficult to argue that these risks are in any way comparable to those associated with the operation of a

250 MW steam-turbine generating plant. However, one of the legacies of PURPA is that most utilities developed interconnection requirements for cogeneration projects, biomass plants, and geothermal facilities that are orders of magnitude larger and more expensive than small-scale PV systems. These larger projects tend to be owned and operated by sophisticated business entities for whom the cost of retaining legal and technical experts to negotiate interconnection requirements are a regular and accepted cost of doing business. By contrast, asking a residential customer to bear the cost of hiring a lawyer and a consulting engineer to review and negotiate interconnection requirements for a kilowatt-scale PV system is a non-starter: Most residential customers will simply abandon the project.

A related problem with interconnection requirements is that they frequently differ from one utility to the next, even within a single state. This is a legacy of the deference historically granted to utilities with respect to maintaining control of their own transmission and distribution networks. This lack of uniformity creates a much greater burden for the vendors and users of small-scale PV systems than it does for the developers of large (multi-megawatt) generating facilities.

In our view, the solution to both these problems is uniform adherence to interconnection standards developed by nationally-recognized independent authorities. For the most part, the appropriate standards are already in place. The National Fire Protection Association publishes the National Electrical Code (NEC), which is widely used by municipalities to develop local building and electrical codes. The NEC contains an entire chapter (Article 690) dedicated to the wiring and installation of PV systems. The Underwriters Laboratories (UL) recently published Subject 1741, its standard for static inverters and charge controllers used in PV systems. Finally, the Institute of Electrical and Electronic Engineers (IEEE) is currently finalizing a revised version of P929, its recommended practice for utility interconnection of PV systems.

Together, these standards appear to address all of the legitimate safety and power quality concerns raised by utilities and municipalities. Although compliance with these rigorous standards poses a challenge for PV manufacturers and installers, the general view among the PV industry appears to be that the benefits of uniformity would far outweigh the costs of complying with stricter standards.

In addition, there are legitimate business reasons for utilities themselves to favor uniform interconnection standards. First, case-by-case review of system configurations and specifications by utility personnel is time-consuming and expensive. As market penetration of small-scale renewables increases, these costs will escalate. In an era where competitive concerns are leading to dramatic cost-cutting efforts by utilities, case-by-case review of interconnection requirements seems like a terrible waste of utility resources.

Second, utilities that choose to actively participate in PV markets will themselves benefit from simplified uniform interconnection standards that appeal to their customers.

Third, there is a fine line between a utility's legitimate concerns regarding safety and power quality and a utility's illegitimate attempts to stifle competition by discouraging self-generation among their customers. Utilities unwilling to accept uniform national standards may find themselves vulnerable to allegations of anticompetitive behavior. For instance, AT&T's intransigence on interconnection issues was one of the principal reasons the Department of Justice initiated the antitrust suit that led to the breakup of the Bell Companies.

Uniform standards can be adopted one of two ways: through voluntary acceptance by utilities, or through legislative or regulatory mandates. Mandates would require action by Congress or the Federal Energy Regulatory Commission. In our view, the preferred approach would be for the utilities to voluntarily accept the NEC, UL, and IEEE standards as the sole and exclusive requirements that customers would have to meet. As it currently stands, utilities participate in the development of these standards but are under no obligation to adopt them as their own. Utilities frequently use their discretionary authority to impose additional requirements that go beyond the recommended standards, raising the cost of compliance for manufacturers and consumers alike.

3. CONTRACT TERMS AND CONDITIONS

In addition to technical requirements, interconnection agreements typically contain a variety of contract terms and conditions relating to the installation and operation of the generating facility. Our initial inquiry reveals that these contracts range in length from two pages to thirty-six, and in scope from simple agreements written in readable prose to elaborate contracts with preambles, legal definitions, force majeure provisions, indemnity requirements, integration provisions, and insurance requirements – to name just a fraction of the issues covered.

Authority over contract terms and conditions rests squarely with utility regulators. To our knowledge, however, only the New York Public Services Commission (PSC) has explicitly addressed the issue of overly burdensome contract terms and conditions in PV interconnection agreements. In our view, the PSC's handling of these issues provides a valuable model for other states.

New York passed a law during 1997 that makes net metering available to residential customers with PV systems sized 10 kW or smaller. When the state's utilities filed proposed tariffs to implement the new law, renewable energy advocates – led by the Natural Resources Defense Council – argued that net metering contracts proposed by the utilities included terms and conditions that were burdensome and unnecessary and that major modifications were necessary to ensure the effective implementation of the net metering law.

In February 1998, the PSC issued an order implementing the net metering law in which it rejected elements of the utilities' proposed contracts as overly burdensome, including insurance and indemnification provisions.

3.1 Liability Insurance Requirements

Utilities frequently require large-scale generating facilities to carry liability insurance protecting the facility owner and the utility against property damage, personal liability claims, and injury lawsuits associated with the operation of the generating facility. Renewable energy advocates have long argued that high amounts of insurance coverage are unnecessary for small-scale renewable generating facilities, and that these coverage requirements are a substantial barrier to customer investment in renewables.

In New York, several utilities proposed that net metering customers carry liability insurance in amounts between $500,000 and $1,000,000. The PSC rejected these proposals, finding that "utility proposals on liability insurance are clearly burdensome and overly costly," and at least in one case "are practically impossible for residential customers to meet." The PSC concluded that utilities were limited to requiring customers to demonstrate that they carry at least $100,000 in liability coverage through their homeowners' policies. This limit is well within the conventional coverage most homeowners already carry.

3.2 Indemnification Requirements

An indemnity is an agreement between two parties where one agrees to secure the other against loss or damage arising from some act or some assumed responsibility. In the context of customer-owned generating facilities, utilities often want customers to indemnify them for any potential liability arising from the operation of the customer's generating facility.

In New York, most of the utilities included indemnity provisions in their proposed net metering contracts. In several cases, the indemnity provisions were grossly one-sided. One utility, for instance, proposed an indemnity that would have resulted in the customer having to compensate the utility for liability stemming from the utility's own negligence.

The PSC rejected these indemnity provisions, after pointing out that existing negligence and contract principles were sufficient to govern the relationship between utilities and their net metering customers. Accordingly, the PSC accepted this reasoning, and instructed the utilities to strike all indemnification provisions from their proposed tariffs and contracts.

3.3 Summary of Contractual Issues

Although these and other contractual issues have come up in other states where customers have proposed utility interconnection of small-scale PV systems, customers rarely had the opportunity to challenge the utilities' proposed contracts as being unreasonable or unduly burdensome. Instead, customers have faced the choice of accepting the contracts as proposed, abandoning their interconnection efforts, or interconnecting illegally. From a public policy perspective, none of these options is attractive. The New York PSC's decision represents the first time that utility regulators have directly addressed the need for simplified, standardized contracts for residential-scale PV systems.

4. FEES AND CHARGES

Another substantial barrier to the commercialization of grid-connected PV systems is the imposition of fees and charges that are not commensurate with the size and scale of the generating facility. These fees and charges may dramatically increase the cost of installing, interconnecting or operating a small-scale PV system. In some instances, these fees completely offset the energy savings from the installation of the PV system. These expenses typically fall into one of several categories: permitting fees, interconnection-related fees, or operating charges such as customer charges, metering fees, or standby charges.

4.1 Permitting Fees

In most municipalities (cities and counties), the installation of a grid-connected PV system requires a permit from the local building department. Permitting fees are often based on a percentage of the value of the property 'improvement' for which a permit is sought. Because PV systems have a high up-front capital cost which is recouped over the long term through the energy savings, these fees can take a big bite out of the energy benefits.

For example, one California homeowner paid $500 to the city for a building permit to install his 3 kW PV system. This customer expects the PV system to provide approximately $60/month in bill savings, which means that about eight months' worth of energy generation will go towards recouping the city's building permit fee.

The issue of building permit requirements for small-scale PV systems requires further analysis. A legal question that needs to be resolved is whether a PV system is 'affixed' to a building, and therefore becomes part of the real property (in which case it is considered an improvement to the building requiring a permit), or alternatively whether a PV system can be removed from the structure, in which case it may be considered personal property rather than real property. This issue has important implications both for building permit requirements and for property tax assessments.

4.2 Interconnection-Related Fees and Charges

Utilities often impose engineering, inspection, and other fees for reviewing system designs, certifying components, testing equipment, and inspecting facilities. These fees vary substantially from one utility to the next, but have one thing in common: They constitute a disproportionate burden on small-scale generating facilities.

Because utilities and municipalities are more accustomed to reviewing and inspecting large-scale facilities, they tend not to recognize that even very modest fees can wipe out much of the energy savings a customer is trying to capture with a PV system.

For example, a homeowner in New Hampshire recently testified at a legislative hearing that his utility had imposed a $900 fee to conduct a design review of his 900 Watt PV system. The utility then required him to purchase and install relays to protect against over/under frequency and over/under voltage conditions, in spite of the fact that his inverter already contained the necessary protective relays. The price for the relays was $450. These two requirements alone increased the installed cost of the system by $1.50/Watt, or approximately 15%. In addition, the utility required an annual test of the protective relays to ensure that they maintained their calibration, for which the utility charged $100. The cost of this annual test effectively offsets half of the annual energy production from the PV system.

The experience of this New Hampshire homeowner is not typical, but it illustrates the additional financial burden that may be imposed on PV system owners. The solution is not to ask utilities or municipalities to absorb the cost of essential inspections and tests; it is unreasonable to expect other utility customers or community residents to pick up the tab for costs directly associated with the installation of a PV system. Rather, the solution is to ensure that the number of inspections and tests, and the costs associated with these tests, are reduced to an absolute minimum that is consistent with the public's interest in ensuring safety and power quality. In our view, the ultimate goal is to make the installation of a PV system no more complicated than installing and interconnecting a new air conditioner, or obtaining a new electrical hookup.

4.3 Additional Operating Charges

In addition to interconnection-related charges, utilities frequently impose additional fixed and variable charges on the routine operation of generating facilities. Two of the most common are additional metering charges and standby charges.

4.3.1 Metering Charges

Additional metering charges are usually imposed only when dual meters are used to separately measure electricity flows in and out of the customer premises. They are usually imposed as a fixed monthly charge, ranging from $4 - $8 a month. Although these figures sound modest, they can have a dramatic impact on the effective value to the customer of a PV system. Because they are fixed charges, their impact is directly proportional to the size of the system. Table 1 illustrates the effects of a $5 monthly charge for reading a second meter.

TABLE 1: EFFECTS OF A $5 MONTHLY CHARGE *

Size of PV System	0.5 kW	2 kW	10 kW
Total Monthly Charge	$5.00	$5.00	$5.00
% of Monthly Energy Value	76%	19%	4%
Equivalent Days' Output	23	6	1

* Assumes capacity factor = 18%; electricity value = $0.10/kWh; net metering

Thus, a $5 monthly metering charge is equivalent to 1 day's worth of monthly output for a 10 kW system, but a stunning 23 days' worth of monthly output for a 500 W system. This means that imposing a $5 monthly metering charge for a 500 Watt system will increase the payback time by a factor of four.

4.3.2 Standby Charges

Standby or reservation charges are often imposed on larger self-generating customers to reflect the fact that the utility is required to have enough generating capacity in reserve to accommodate the customer's load if their generating facility fails or otherwise goes off-line.

However, imposing standby charges on kilowatt-scale generating facilities is difficult to justify when the amount of reserve capacity that the utility needs to have available to respond to the 'outage' of a small-scale PV system is no greater than what the utility already is required to reserve in order to accommodate routine fluctuations in customer demand. For example, residential customer demand is frequently irregular, cycling higher and lower as energy-intensive appliances such as refrigerators, water heaters, clothes dryers, and air conditioners cycle on and off. Many such appliances can cause demand fluctuations of 1 kW or more. Yet utilities accommodate these fluctuations within their routine operations, even though the impact of these fluctuations is comparable to the presence of a customer's PV system.

One particularly telling illustration of how severe the impact of additional charges can be on the economics of PV self-generation was the tariff proposed by Pacific Gas & Electric Company to implement California's net metering law in 1995. The tariff called for an additional customer charge of $14/month, and a reservation (standby) charge of $2.15/kW of generating capacity per month. Table 2 shows the effects of these charges.

TABLE 2: EFFECTS OF PROPOSED PG&E TARIFF*

Size of PV System	0.5 kW	2 kW	10 kW
Total Monthly Charge	$15.08	$18.30	$35.50
% of Monthly Energy Value	164	50	10
Equivalent Days' Output	49	15	3

*Assumes capacity factor = 18%; electricity value = $0.14/kWh; net metering

These figures show that the monthly charges for a 500 W PV system would have been more than 1.6 times the value of the energy from that system. Obviously, these charges would have acted as a complete bar to the installation of small-scale PV systems in PG&E's service territory, since for the size of systems typically installed by residential customers, these customers would not only never recoup the cost of the PV system but would be losing money every month. After this was pointed out to the California Public Utilities Commission when it was reviewing the net metering tariffs, the Commission flatly rejected PG&E's proposal as being inconsistent with the intent of the net metering law, and PG&E was compelled to drop these and other supplemental charges from its proposed tariff.

4.4 'Competitive Transition' Charges

Another potential barrier to PV installation is the direct result of electricity industry restructuring. Many of the costs that historically have been part of the utilities' rate base become above-market costs in a competitive environment. Utilities can no longer pass these costs on to their customers because they put the utilities at a competitive disadvantage relative to electricity providers who are not saddled with these costs. As a result, regulators across the country are separating out these 'stranded costs' and imposing them on all consumers – regardless of who they choose as their electricity providers – in the form of a non-bypassable charge referred to as a 'competitive transition charge' (CTC).

The imposition of a CTC requires making some difficult policy decisions. In two states that are among the first to establish and define the CTC, legislators and regulators have provided that customers cannot avoid the charges by self-generating. Accordingly, customers who install new capacity for self-generation will continue to pay the CTC on the amount of electricity they previously would have purchased. This acts as a substantial disincentive for investment in grid-connected PV systems.

4.4.1 California's Competitive Transition Charge

The CTC in California is somewhat variable, but is expected to average around 4 – 5 ¢/kWh. California's restructuring law provides an exemption from the CTC for residential customers, by specifying in Section 371(c) of the Public Utilities Code that residential customers can alter their pattern of electricity purchases through activities on their side of the meter without having to pay the CTC.

Commercial and industrial customers who previously could have used PV generation to offset the full retail price per kWh are not eligible for this exemption. Thus, if the owner of an office building were to install a 10 kW PV system that generates 1,300 kWh/month, the customer's savings from the installation of the PV system would be reduced by approximately 1/3, reflecting the amount of the CTC imposed on the difference between the new reduced energy use and the historical energy use.

The California CTC is particularly frustrating for PV advocates because the imposition of the charge is at odds with other California public policies that are intended to encourage investment in PV and other renewables. In particular, the California restructuring law provides nearly $54 million over five years in rebate or 'buydown' funds for customers investing in emerging electric generating technologies, including PV. Under this program, the State of California will be paying customers a rebate of up to $3/Watt to invest in grid-connected PV systems. Although commercial and industrial customers in California have expressed interest in participating in the buydown program, they have been discouraged by the prospect of having to pay the CTC on their energy savings. Ironically, both the CTC and the buydown program are expected to last approximately five years, so prospective PV investors have no reasonable expectation of having the buydown program outlast the CTC.

4.4.2 Pennsylvania's Competitive Transition Charge

Pennsylvania's restructuring law also imposes a CTC on self-generation. Section 2808(a) of the law specifies that "if a customer installs on-site generation which operates in parallel with other generation on the public utility's system and which significantly reduces the customer's purchases of electricity through the transmission and distribution network, the customer's fully allocated share of transition or stranded costs shall be recovered from a customer through a competitive transition charge."

The Pennsylvania Public Utilities Commission, charged with determining what constitutes a 'significant' reduction in a customer's purchase of electricity, concluded that 10% was the appropriate threshold figure. Therefore, a newly self-generating customer must pay the CTC on the amount of reduced usage due to self-generation in excess of 10% of its prior year usage. This provides some room for customers to use PV generation to offset load at the full retail rate – but not much.

5. OTHER BARRIERS

Customers frequently identify two other issues as barriers to PV commercialization: the lack of institutional mechanisms for long-term financing of PV systems at reasonable rates, and the disproportionate taxation of PV systems. Financing concerns focus on the capital-intensiveness of PV investments, which make the cost of energy highly dependent on the terms and conditions under which the PV systems is financed. The dominant tax concern is the assessment of property taxes on the cost of building-integrated PV systems, which can swamp the energy savings associated with the PV system. Length restrictions prohibit us from addressing these issues in greater length, but they are being studied as part of this project and will be addressed in our final reports.

6. CONCLUSIONS

The successful expansion of PV from its current niche markets to broader grid-connected markets will require the satisfactory resolution of the issues identified in this paper. Interconnection requirements that vary from utility to utility will need to be replaced with uniform requirements based on national standards. Purchase and sale agreements will need to be simplified, and regulators will need to protect consumers against inappropriate terms and conditions. Fees and charges will need to be reasonable and commensurate with the size and complexity of the generating facility. Addressing these issues soon will help pave the way for the commercialization of PV technology.

7. ACKNOWLEDGMENTS

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